

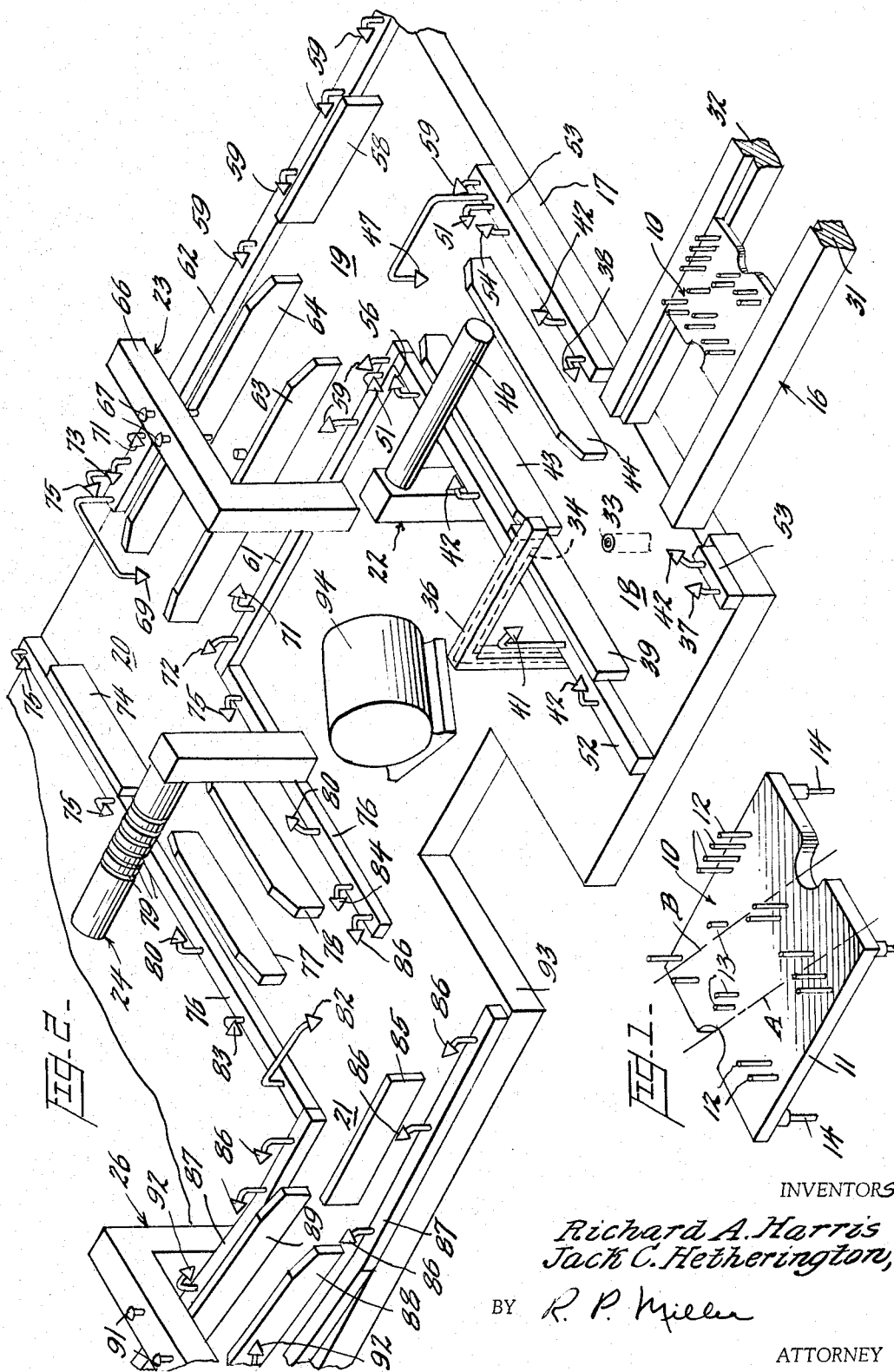
Oct. 4, 1966

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AUTOMATIC SYSTEM FOR SORTING ARTICLES IN ACCORDANCE
WITH PHYSICAL DIMENSIONS

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3 Sheets-Sheet 1



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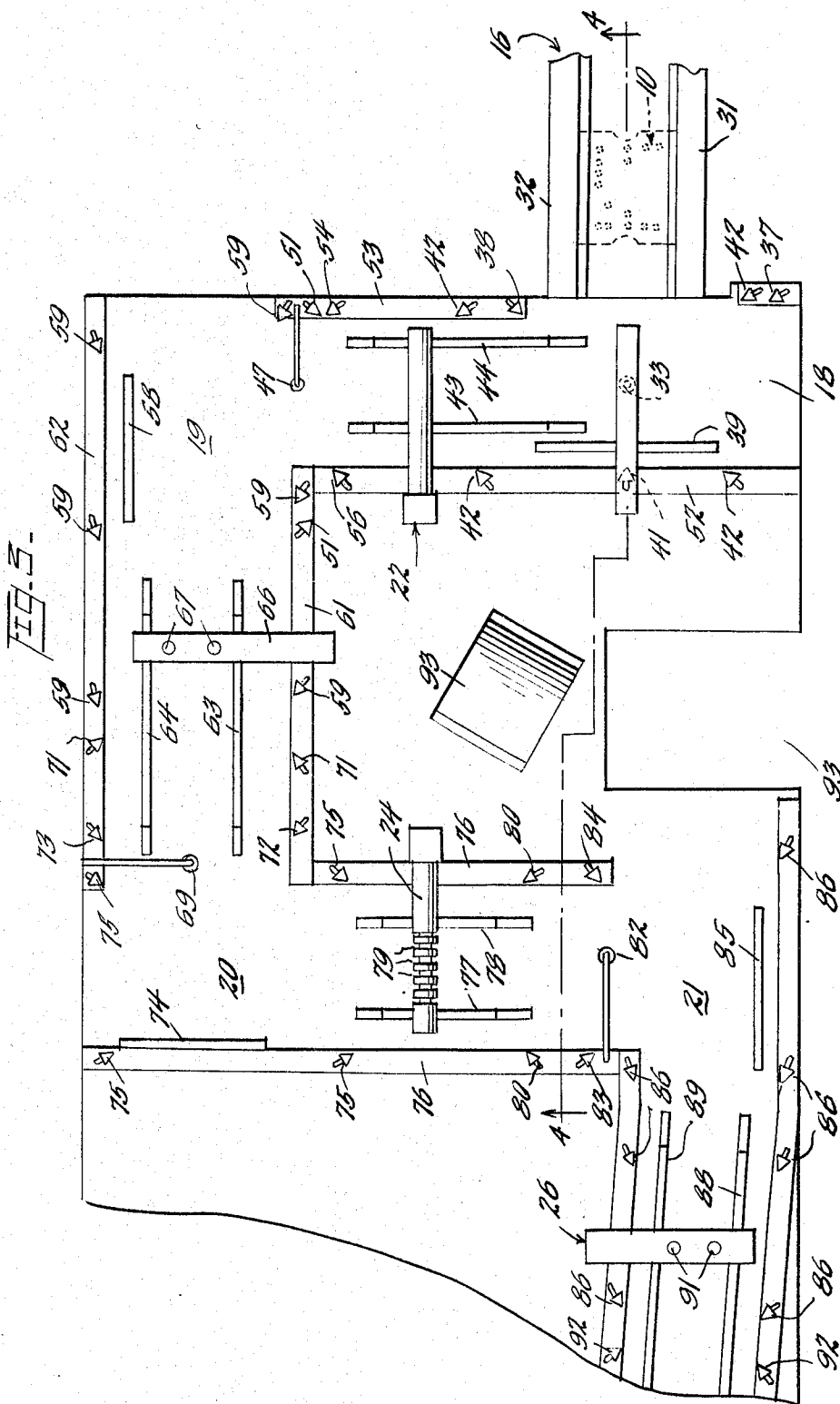
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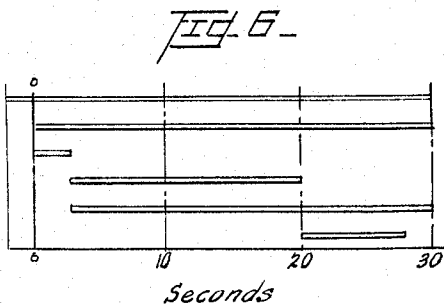
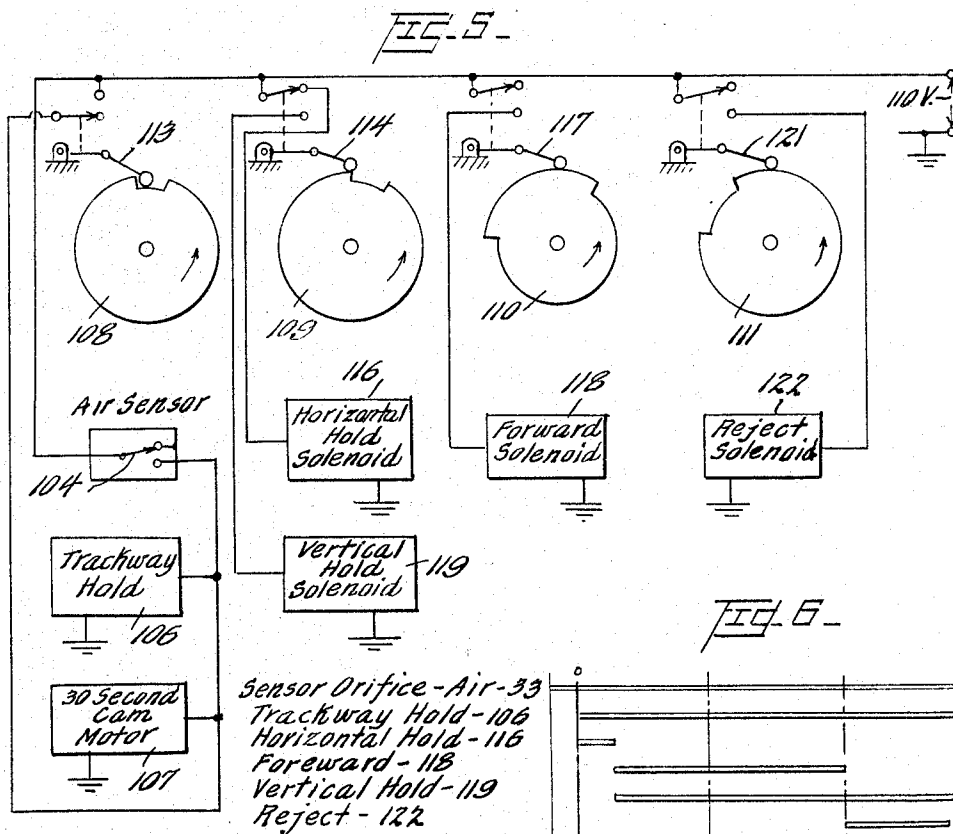
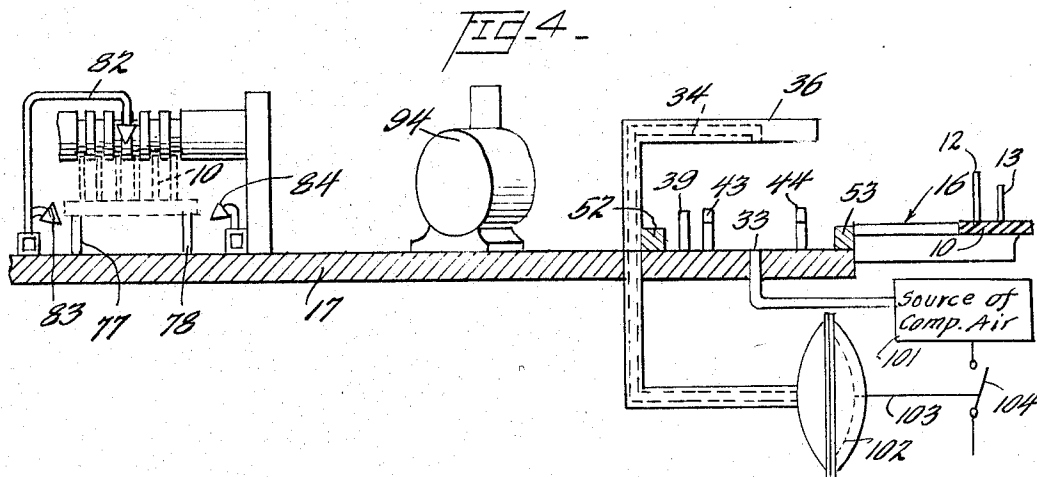
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AUTOMATIC SYSTEM FOR SORTING ARTICLES IN ACCORDANCE WITH PHYSICAL DIMENSIONS

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This invention relates to an automatic system for sorting articles in accordance with physical dimensions, and more particularly to a system wherein pneumatic forces are used to advance articles past gauging devices and where pneumatic forces are also employed to eject articles retained by any of the gauging devices.

In the manufacture of many diverse types of articles, it is necessary to check the physical dimensions of the articles or the location of one or more elements on the articles with respect to one or more other elements. One type of article that is extremely difficult to accurately and rapidly check is a circuit module having projecting electrical terminals. These modules may be constructed of fragile plastic or other materials, thus precluding the use of positive gripping elements to advance the modules through the gauging device. Further, in inspecting and gauging such a module, many dimensions or locations must be checked or verified and the modules accordingly sorted.

An object of the invention resides in a new and improved automatic system for sorting articles in accordance with physical dimensions.

Another object of the invention is to provide a gauging maze through which articles are pneumatically advanced and pneumatically ejected or sorted in accordance with various physical characteristics of the articles.

A further object of the invention is to provide a gauging device spaced from a trackway for retaining defective articles having physical dimensions exceeding predetermined limits together with facilities for moving the defective articles back down and out of the trackway.

An additional object of the invention is the provision of a maze trackway having a plurality of gauging facilities for checking the physical dimensions or relative locations of a plurality of diversely located elements projecting from an article, such as a circuit module.

With these and other objects in view, the present invention contemplates a gauging maze through which articles are pneumatically advanced and sorted in accordance with various physical characteristics. The maze includes a trackway having a plurality of angularly connected sections along which are positioned nozzles for pneumatically advancing the articles. Spaced along the upper surface of each trackway section is a gauging device which will retain an advancing article having physical characteristics exceeding predetermined limits. Following each pneumatic advance of the articles, nozzle devices are actuated to direct reverse blasts of air against any article retained by a gauging device. If an article is retained, then the reverse blast of air blows that article back down the trackway sections and out through an open end portion located at the junction of that trackway section with the preceding section of trackway.

Other objects and advantages of the present invention will be apparent from the following detailed description when considered in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a circuit module that may be gauged and sorted by the apparatus shown in the other figures;

FIG. 2 is a perspective view of a pneumatically con-

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trolled article gauging and sorting apparatus embodying the principles of the present invention;

FIG. 3 is a top plan view of the article gauging and sorting apparatus shown in FIG. 2 and particularly illustrating an arrangement of nozzles for incrementally advancing articles through a gauging maze;

FIG. 4 is a cross sectional view taken along line 4—4 of FIG. 3 showing two of the gauging trackways together with the facilities for initiating the cycle of operation for the overall apparatus;

FIG. 5 is a schematic diagram showing control facilities for imparting air to the various nozzles shown in the other figures; and

FIG. 6 is a timing diagram depicting the periods during which air is projected through the various nozzles.

Referring first to FIG. 1, there is shown a circuit module generally designated by the reference numeral 10 which may be advanced and gauged by the apparatus shown in the other views. This circuit module includes a base of phenolic plastic 11 having a plurality of conductive mounting or terminal pins 12 and 13 extending through the base. These terminal pins 12 and 13 may be positioned in various arrays and may be of various heights. As illustrated in FIG. 1, and in other views, the pins 13 are shorter than the pins 12. Depending from the underside of the base 12 are a number, four in the present instance, of depending terminal posts or mounting legs 14. Circuit components may be subsequently connected or wired to the various terminal pins and posts.

General description

The apparatus shown in the drawing is designed to check or gauge the height, straightness, or relative location of the terminal pins 12 and 13. This apparatus comprises a feed track 16 along which modules 10 advance onto a platform 17. The module 10 is advanced along trackway sections generally designated by the reference numerals 18, 19, 20, and 21 formed on the platform 17. If the module 10 moves along the trackway section 18, it passes a first gauging device 22 which checks the height of the pins 12. Next, the module advances along trackway section 19 past a gauging device 23 which checks the height of the short terminal pins 13. As the module 10 moves along trackway section 20, it passes a gauging device 24 which ascertains the straightness of the terminal pins 12 and 13. Finally, the module 10 is advanced along trackway section 21 and past a gauging device 26 which functions to ascertain the relative position of certain of the pins 12 and 13 or the height of certain pins which are more readily determined than by the gauging devices 22 and 23. If any module 10 is retained by a gauging device 22, 23, 24, or 26, pneumatic facilities are actuated following advance of the modules to impinge a reverse blast of air on the retained module to force this module back down its associated trackway and off of the platform 17.

Details of the pneumatic gauging apparatus

Considering now the details of construction of the apparatus for effecting the operations generally outlined above, attention is directed to FIGS. 2 and 3. The feed track 16 comprises a pair of parallel guide tracks 31 and 32 cut out or oppositely grooved to support opposite edges of the module 10. The tracks 31 and 32 may be a part of a vibratory feed mechanism which functions to continually advance the modules 10 toward the platform 17 or the tracks 31 and 32 may be mounted to provide a gravity type feed arrangement. As a module 10 advances onto the platform 18, it interrupts an air stream emanating from a port 33 formed in the floor of the trackway 18. The air stream emanating from the port 33 is picked up

in a passageway 34 formed in an L-shaped bracket 36 mounted on the platform 17. The maintenance of an uninterrupted air stream between the port 33 and the passageway 34 holds a control circuit from initiating a cycle of operation. However, the interruption of the air stream by the advance of a module initiates a cycle of operation whereupon air is passed to a pair of horizontal hold nozzles 37 and 38 which function to momentarily hold the module 10 against a back plate 39.

Upon initiation of a cycle of operation, air is immediately impressed through a nozzle 41 to project a stream of air against the next succeeding module 10 proceeding down the trackway 16. This air stream will hold the stack of modules 10 in the trackway 16 until the module over the port 33 is advanced past the first gauging device 22 and comes to rest. In order to advance the module 10 along the trackway 18, a series of nozzles 42 are arranged along opposite sides of the trackway 18.

As the module 10 advances along the trackway 18, the base 11 engages and rides up on a pair of bevelled ended guide rails 43 and 44. Thus, the weight of the module 10 is removed from the pins 14 and placed on the edges of the plastic base 11. The gauging device 22 consists of a rod or an abutment 46 spaced a predetermined distance above the top surface of the guide rails 43 and 44 that a module having terminal pins 12 of a predetermined height will pass by the rod 46 and move into register with a nozzle 47 receiving a stream of air that is projected vertically downward to function to hold the module 10 from further advancement into the trackway 19. If any of the pins 12 extend beyond a predetermined height, the module 10 will be retained by the rod 46. Upon completion of the forward blast of air imparted to the nozzles 42, a reverse blast of air is passed to a pair of oppositely positioned reject nozzles 51 to impress streams of air from opposite sides of trackway against the module 10 retained by the rod 46. The module 10 will be thus blown back down the trackway 18 and out an open end of the trackway located between a pair of mounting bars 52 and 53. These bars 52 and 53 serve as mountings for the various nozzles and more or less define the limits of the trackway 18.

If the module 10 passes the gauging device 22, it is retained by the air emanating from the vertical hold nozzle 47 during the remainder of the initial cycle of operation of the apparatus. This initial cycle of operation is controlled by timing units actuating the air supply running to the various nozzles.

As soon as the initial cycle of operation is complete, the air stream emanating from the nozzle 41 is interrupted to permit the next succeeding module 10 to move onto the trackway 18 to again interrupt the air stream emanating from the port 33 to again initiate another cycle of operation.

Considering now the module 10 positioned under the nozzle 47, the initiation of the second cycle of operation results in the interruption of the air emanating from the nozzle 47 and air being passed to horizontal hold nozzles 56 which are directed against the module 10 now positioned under the nozzle 47 whereupon this module advances into engagement with a stop plate 58 positioned on one side of the trackway 19. After a short time delay, air is removed from the horizontal hold nozzles 37, 38, 56 and 57. At this time, air is also impressed to a second set of forward nozzles 59 located along opposite sides of the trackway 19 in mounting bars 61 and 62. The module 10 thus advances along trackway 19 and engages and rides up upon oppositely bevelled guide rails 63 and 64 and then passes the gauging device 23. The gauging device 23 consists of an L-shaped bracket 66 having a plurality of threaded gauging pins or bolts 67. These bolts or pins may be adjusted to gauge the height of the short pins 13 of the module 10. An adjustable pin or pins 68 may also be mounted in the platform 17 to project between the

guide rails 63 and 64 to check the height of any pin or pins that depend from the underside of the module 10.

If the short pins 13 and the depending pins are of proper height, the module 10 will pass along the trackway 19 until held by an air stream emanating from a vertical hold nozzle 69. After a short time delay, air is impressed to a pair of oppositely disposed reject nozzles 71, identical to nozzles 51, so that a module held by the gauging device 23 is thrust back down the trackway 19 and off the open end of the platform 17 into a suitable receiving receptacle.

Upon a subsequent cycle of operation, the module 10, positioned beneath the vertical hold nozzle 69, is advanced by air emanating from a pair of oppositely disposed horizontal hold nozzles 72 and 73 against a stop plate 74. Air is then impressed on a third series of forward jets 75, mounted to extend through opposed side bars 76, to advance the module past the gauging device 24. The module again rides up on a pair of guide rails 77 and 78 to move the pins through circumferential slots 79 formed in a rod 81. Any of the pins that are bent will not pass through the aligned circumferential slot and thus the module will be held on the guide rails 77 and 78. A module that passes this gauging operation moves into position to be held by air emanating from a vertical hold nozzle 82. If the module 10 has bent pins, the module will be retained on the rails 77 and the subsequent application of air to a pair of oppositely disposed reject nozzles 80 forces the module back down the trackway 20 and off of the platform 17 into a receiving receptacle.

During the next cycle of operation, a module positioned beneath the vertical hold nozzle 82 is advanced by air emanating from a pair of oppositely disposed horizontal hold nozzles 83 and 84 against a stop plate 85. Air is then imparted to another series of forward nozzles 86 extending from bars 87 to move the module up and along a pair of guide rails 88 and 89. It will be noted from an inspection of the drawings, that the guide rails 88 and 89 are canted with respect to the direction of movement of the module 10. The module 10 will thus move at an oblique angle with respect to the trackway 21 to advance the terminal pins past the gauging device 26. This gauging device 26 includes a plurality of depending adjustable gauging pins 91 which can be set to check the height of short terminal pins 13 that were not readily accessible to the gauging elements 67. In the alternative, the pins 91 may be used to check the clearances of oblique paths (such as paths designated A and B of FIG. 1) which are formed between arrays of terminals 12 and 13. If a module 10 is retained by the gauging device 26, air emanating from a pair of reject nozzles 92 forces the module back down the trackway 21 and off of the platform 17 through an opening 93 formed in the platform 17 and into a suitable receiving receptacle.

In order to facilitate the movement of the modules 10 along the various trackways, a vibratory motor 94 is secured to the platform 17. Vibrations imparted to the platform 17 are impressed on the module 10 so that the module is cyclically elevated from the platform. The air stream impinges against the module and moves it with a minimum amount of frictional drag or scraping along the floors of the trackway.

Controls for overall operation

An understanding of the controls for overall apparatus shown in FIGS. 2 and 3, may be had by reference to FIGS. 4, 5 and 6. As shown in FIG. 4, the module 10 advances to interrupt air stream emanating from the port 33. Air is continually applied to port 33 from a source of compressed air 101. This air normally passes through the passageway 34 to act against a resilient diaphragm 102 that is extended to position a rod 103 to hold a contactor 104 in an open position. Interruption of the air stream results in contraction of the diaphragm and the subsequent closure of the contactor 104 to complete a circuit (see FIG. 5) to a solenoid 106 and a cam motor

107. Energization of the solenoid 106 operates a valve (not shown) to impart air to the nozzle 41 which functions to hold the subsequent modules 10 in the trackway 16. Energization of the motor 107 applies driving power to a series of cams 108, 109, 110 and 111 to rotate these cams at a predetermined rate to sequentially control the application of air to the various nozzles shown in FIGS. 2 and 3.

More particularly, cam 108, after a short delay (see FIG. 6), operates a follower contactor 113 to complete a holding circuit for the solenoid 106 and the cam motor 107. This holding circuit is completed prior to the time that the cam 109 actuates a follower contactor 114 to interrupt a circuit to a horizontal hold solenoid 116 which controls a valve (not shown) for applying air to the horizontal hold nozzles 37 and 38, 56 and 57, 72 and 73, and 83 and 84. With air emanating from the horizontal hold nozzles, the modules 10 are held for a short period of time (see FIG. 6) against the respective stop plates 39, 58, 74 and 85.

Next, after a delay, the cam 110 operates a follower contactor 117 to complete an energizing circuit for a forward solenoid 118 which operates a valve (not shown) for applying air to the forward nozzles 42, 59, 76 and 87. At the same time that the solenoid 118 is operated, the cam 109 is effective to interrupt the circuit for the horizontal hold solenoid 116 thereby interrupting the air emanating from the horizontal hold nozzles whereupon the air emanating from the forward nozzles moves the modules along the associated trackways 18, 19, 20 and 21. Simultaneous with the operation of the forward nozzles, the cam 109 energizes a vertical hold solenoid 119 which controls the application of air to the vertical hold nozzles 47, 69 and 82 whereupon those modules advanced past the gauging devices 22, 23, 24 and 26 are held beneath the respective vertical hold nozzles.

After a time (see FIG. 6) sufficient to advance the modules 10 into position to be held by the vertical hold nozzles, the cam 111 is rendered effective to operate a follower contactor 121 to complete a circuit to a reject solenoid which applies air through valves (not shown) to the reject nozzles 51, 71, 80 and 92. The air emanating from reject nozzles is effective to remove any module held by any of the gauging devices 22, 23, 24 and 26 back down its associated trackway and off of the platform 17. Following operation of the reject solenoid 122, the cam 108 is rotated into position to open the follower contactor 113 to interrupt the holding circuit for the solenoid 106 and the cam motor 107.

It will be appreciated that as soon as the forward solenoid 118 is operated, the forward nozzles 42 are rendered effective to move the module 10 from over the port 33 thus the air stream is again impressed through the passageway 34 to the diaphragm 102. Diaphragm 102 expands to open the contactor 104 which interrupts the initial energizing circuit for the solenoid 106 and the cam motor 107. However, the cam motor 107 is held energized for a complete cycle of operation by the locking circuit maintained through the follower contactor 113.

Just prior to a complete rotation of the cams, the cam 108 again presents a low portion to open the follower contactor 113 and thus deenergizes the cam motor 107 whereupon the control circuit is in condition for another cycle of operation. At this time, the solenoid 106 is deenergized to interrupt the air stream flowing from the nozzle 41 and the next succeeding module 10 moves down the trackway 16 and over the port 33 to initiate the subsequent operation of the apparatus.

The module 10 is illustrated as being square, but the gauging apparatus can be simply modified to accommodate modules of rectangular configuration. In this instance, assuming the modules as being fed lengthwise down the trackway 16, then, the trackways 19 and 21 are made wider than the trackways 18 and 20 to ac-

commodate the modules as they advance in different orientations.

It is to be understood that the above described arrangements and construction with elemental parts, are simply illustrative of an application of the invention and many other modifications may be made without departing from the invention.

What is claimed is:

1. In an apparatus for sorting articles in accordance with a physical dimension, a trackway having an open end, a gauging device spaced from said trackway for retaining articles having a physical dimension exceeding a predetermined magnitude, means for advancing articles from said open end and along said trackway past said gauging device, and means for moving any articles having physical dimensions exceeding said predetermined magnitude and retained by said gauging device back down said trackway and out said open end.
2. In a pneumatic inspection system for sorting parts in accordance with physical dimensions, a trackway, first pneumatic devices positioned along opposite sides of said trackway for advancing parts therealong, an obstruction projecting into the path of the parts moving along said trackway for engaging and holding a part having a dimension exceeding a predetermined value, second pneumatic devices for advancing parts retained by said obstruction back down said trackway, and means for alternately operating said first and second pneumatic devices.
3. In a system for sorting articles in accordance with physical dimensions, a straight trackway, a gauging device spaced from the trackway for retaining articles having a physical dimension exceeding a predetermined magnitude, a plurality of forward nozzles arranged along the sides of said trackway for projecting air against articles positioned on said trackway to move said articles past said gauging device, reverse nozzles arranged along said trackway past said gauging device in the direction of movement of said articles along said trackway for directing air against any article retained by said gauging device to move said article back down said trackway, and means for alternately supplying air to said forward nozzles and then said reverse nozzles, and means for vibrating said trackway.
4. In an article gauging and sorting apparatus, a trackway having a plurality of angularly connected sections, each trackway section having open sections at juncture with the preceding section, a plurality of gauging devices each of which is spaced from a trackway section a distance equal to one dimension of a section of an article to be gauged, a stop means positioned on each trackway for retaining an article advanced from a preceding trackway section, means for pneumatically intermittently advancing a succession of articles past said gauging devices into engagement with the stop means positioned on the next succeeding trackway section, and means rendered effective between intermittent advances of said articles for directing pneumatic forces against any articles retained by said gauging devices to pneumatically advance said retained articles back down and off of said trackway sections through said open sections.
5. In a system for sorting articles in accordance with physical characteristics of the articles,

a trackway open at one end and having a lateral entryway for receiving said articles,
 an abutment spaced from the bottom of said trackway a distance equal to a predetermined dimension of said article and spaced down along said trackway from said entryway and open end,
 means for advancing a succession of articles through said entryway into said trackway,
 means responsive to the advance of each article onto said trackway for advancing said article away from said open end of said trackway and past said abutment, and
 means for periodically directing a blast of air into the space between said abutment and trackway to advance an article held by said abutment back down said trackway and out of said open end.

6. In an article gauging and sorting apparatus, a trackway section having an open end and a port formed in the near said open end,
 means for projecting an air stream through the port,
 means for advancing an article onto said trackway to interrupt said air stream,
 means responsive to the interruption of said air stream for pneumatically advancing said article away from said open end,
 a gauging bar spaced a distance from the upper surface of said trackway for retaining articles having a height exceeding a predetermined dimension,
 air nozzles mounted on opposite sides of said trackway and directed toward the space between said gauging bar and said upper surface, and
 means rendered effective following operation of said pneumatic advancing means for impressing air through said air nozzles to move an article retained by said gauging bar back down said trackway and through said open end.

7. In an apparatus for gauging an article having pins projecting from the top and bottom thereof,
 a trackway,
 a pair of spaced guide rails secured to the top surface of said trackway,
 a first gauging device having a gauging element projecting downwardly toward the space between said guide rails,
 a second gauging device having a gauging element projecting upwardly into the space between said guide rails,
 first nozzle devices positioned along said trackway for advancing said article along said guide rails and between said gauging devices,
 second nozzle devices positioned along said trackway beyond said gauging devices in the direction of advance of said article by said first nozzle device for moving an article having a pin engaged by either of said gauging devices back down said trackway, and
 means for sequentially applying air to said first nozzle devices and then said second nozzle devices.

8. In an apparatus for gauging the length of members extending from an article,
 a trackway,
 a support bracket mounted on said trackway and having an arm extending over and spaced from said trackway,
 a plurality of adjustable pins extending through said arm a predetermined distance for retaining articles having members extending beyond a predetermined length,
 an air nozzle device positioned beyond said support bracket and spaced from said trackway for directing

an air stream down onto said trackway to hold an article advanced past said pins,
 means for pneumatically advancing an article toward said pins to advance an article having members of less than said predetermined length past said pins and into position to be held by said air stream, and
 means positioned between said bracket and said air nozzle device and rendered effective following operation of said pneumatic advancing means for directing air blasts against an article retained by said pins to blow said retained article back down said trackway.

9. In a system for sorting articles in accordance with the positionment of elements projecting from said articles, a trackway having an open end,
 a gauging device spaced from said trackway having slots formed therein to pass said elements projecting from said articles,
 means for individually advancing a succession of articles away from said open end and along said trackway and then past said gauging device, and
 means actuated following operation of said advancing means for moving an article retained by said gauging device back down said trackway and out through said open end.

10. In an apparatus for gauging the straightness of pins extending from an article,
 a trackway,
 a gauging member spaced from said trackway having a plurality of slots for receiving said pins and passing an article having straight pins and retaining an article having bent pins,
 means for directing an air stream of a predetermined duration against an article to advance said article along said trackway whereupon an article having straight pins passes said gauging member and an article having bent pins is retained by said gauging member, and
 means rendered effective following termination of said air stream for directing a reverse air stream against an article retained by said gauging member to advance said retained article back down said trackway.

11. In an apparatus for gauging the clearance between pins arranged in a coordinate array and extending from an article,
 a straight trackway,
 a gauging device spaced from said trackway and having a plurality of gauging members extending toward said trackway,
 means for pneumatically advancing an article toward and past said gauging device,
 a pair of guide rails mounted on and canted with respect to said trackway for guiding said article to move past said gauging device at an oblique angle whereupon said gauging members pass through oblique paths defined by said coordinate array of pins, and
 means for directing a reverse blast of air at an article retained by a pin engaging a gauging member to move said retained article back down said trackway.

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